Technical Report 2006-05

Nearshore Birds in Puget Sound

Prepared in support of the Puget Sound Nearshore Partnership

Joseph B. Buchanan
Washington Department of Fish and Wildlife

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
05-2006

2. REPORT TYPE
Technical Report

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
Nearshore Birds in Puget Sound

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER
2006

6. AUTHOR(S)
Joseph B. Buchanan

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Puget Sound Nearshore Partnership WDFW - P.O. Box 43145, Olympia Washington 98504-3145
U.S. Army Corps of Engineers - P.O. Box 3755, Seattle Washington, 98124-3755

8. PERFORMING ORGANIZATION REPORT NUMBER
2006-05

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Washington Sea Grant - 3716 Brooklyn Avenue NE, Box 355060, Seattle Washington 98195-6716
University of Washington School of Oceanography - Box 357940, Seattle Washington 98195-7940
King Conservation District - 935 Powell Ave SW, Suite D, Renton Washington 98057

10. SPONSOR/MONITOR'S ACRONYM(S)
WDFW, USACE,UW

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
2006-05

12. DISTRIBUTION/AVAILABILITY STATEMENT
DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
available at www.pugetsoundnearshore.org/index.htm

14. ABSTRACT
This document describes Birds found in Puget sound. Three primary marine avian habitats are examined, open water, rocky shoreline and open mud-flats. Distribution , life history, habitat requirements and key stressors are examined. Ecosystem processes affecting nearshore birds is discussed.

15. SUBJECT TERMS
Surf Scoter, Black Oystercatcher, Dunlin, shorebirds, breeding season

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
U	U	U	SAR	24	Bernard L. Hargrave
					19b. TELEPHONE NUMBER *(Include area code)* 206-764-6839

Valued Ecosystem Components Report Series

Puget Sound Nearshore Partnership

Restoring Our Ecosystem Health

The Puget Sound Nearshore Partnership (PSNP) has developed a list of valued ecosystem components (VECs). The list of VECs is meant to represent a cross-section of organisms and physical structures that occupy and interact with the physical processes found in the nearshore. The VECs will help PSNP frame the symptoms of declining Puget Sound nearshore ecosystem integrity, explain how ecosystem processes are linked to ecosystem outputs, and describe the potential benefits of proposed actions in terms that make sense to the broader community. A series of "white papers" was developed that describes each of the VECs. Following is the list of published papers in the series. All papers are available at *www.pugetsoundnearshore.org.*

Brennan, J.S. 2007. Marine Riparian Vegetation Communities of Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-02. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Buchanan, J.B. 2006. Nearshore Birds in Puget Sound. Puget Sound Nearshore Partnership Report No. 2006-05. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Dethier, M.N. 2006. Native Shellfish in Nearshore Ecosystems of Puget Sound. Puget Sound Nearshore Partnership Report No. 2006-04. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Eissinger, A.M. 2007. Great Blue Herons in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-06. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Fresh, K.L. 2006. Juvenile Pacific Salmon in Puget Sound. Puget Sound Nearshore Partnership Report No. 2006-06. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Johannessen, J. and A. MacLennan. 2007. Beaches and Bluffs of Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-04. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Kriete, B. 2007. Orcas in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-01. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Leschine, T.M. and A.W. Petersen. 2007. Valuing Puget Sound's Valued Ecosystem Components. Puget Sound Nearshore Partnership Report No. 2007-07. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Mumford, T.F. 2007. Kelp and Eelgrass in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-05. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Penttila, D. 2007. Marine Forage Fishes in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-03. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Front cover: Black Oystercatcher (courtesy of the University of Washington).

Back cover: Dunlin, left (courtesy of Anita Gould); Surf Scoter, right (courtesy of Scott Streit).

Contents

Acknowledgments

Dave Nysewander provided literature on Surf Scoters and shared comments that improved the Surf Scoter and Black Oystercatcher accounts. The manuscript also benefited from comments provided by Dennis Paulson.

Recommended bibliographical citation:

Buchanan, J.B. 2006. Nearshore Birds in Puget Sound. Puget Sound Nearshore Partnership Report number 2006-05. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.

Available at *www.pugetsoundnearshore.org.*

The Puget Sound Nearshore Partnership Steering Committee initiated the concept of this paper and the others in this series. The Nearshore Partnership Project Management Team (PMT) — Tim Smith, Bernie Hargrave, Curtis Tanner and Fred Goetz — oversaw production of the papers. The Nearshore Science Team (NST) played a number of roles: they helped develop conceptual models for each valued ecosystem component (VEC), in collaboration with the authors; individual members were reviewers for selected papers; and members were also authors, including Megan Dethier, Tom Mumford, Tom Leschine and Kurt Fresh. Other NST members involved were Si Simenstad, Hugh Shipman, Doug Myers, Miles Logsdon, Randy Shuman, Curtis Tanner and Fred Goetz.

The Nearshore Partnership organization is especially grateful for the work done by series science editor Megan Dethier, who acted as facilitator and coach for the authors and liaison with the NST and PMT. We also thank the U.S. Army Corps of Engineers Public Affairs Staff — Patricia Grasser, Dick Devlin, Nola Leyde, Casondra Brewster and Kayla Overton — who, with Kendra Nettleton, assisted with publication of all the papers in the series.

Finally, the Nearshore Partnership would like to thank the Washington Sea Grant Communications Office — Marcus Duke, David Gordon, Robyn Ricks and Dan Williams — for providing the crucial editing, design and production services that made final publication of these papers possible.

This report was supported by the Puget Sound Nearshore Ecosystem Restoration Project through the U.S. Army Corps of Engineers and Washington Department of Fish and Wildlife.

For further information or printed copies of this report, contact Curtis Tanner, Local Project Manager, Puget Sound Nearshore Ecosystem Restoration Project, Washington Department of Fish and Wildlife, 600 Capital Way North, Olympia, Washington 98501-1091.
curtis_tanner@fws.gov.

To download PDF files of this and other reports in the series, visit our Web site at *www.pugetsoundnearshore.org.*

Executive Summary

Puget Sound is home to a great number of birds closely associated with the marine environment. All birds associated with the Puget Sound nearshore environment use one or more of three general habitat types — open water, rocky shoreline and mud flats. The species associated with these habitats that are included in this document are Surf Scoter (*Melanitta perspicillata*), Black Oystercatcher (*Haematopus bachmani*) and Dunlin (*Calidris alpina*). Surf Scoters and Dunlins spend much of the nonbreeding period in Puget Sound and migrate to boreal or Arctic areas to breed; the Black Oystercatcher is essentially a permanent resident. Other than use of agricultural fields by Dunlins, all three species are associated with the marine environment. These associations are very clear and well documented. All three species covered in this document use their focal habitats for foraging and resting, and the Black Oystercatcher also nests in its focal habitat.

For a variety of reasons, each of these three species is an important component of the Puget Sound avifauna. Wildlife observation has become one of the most significant economic activities in Washington and elsewhere in North America, and all three species have value to the bird-watching community. In addition, Surf Scoters are candidate indicators of contaminant loads in the marine environment, as they often carry substantial burdens of heavy metals. Their abundance in Puget Sound has declined, and this is of concern to conservation and management agencies and interest groups. National and regional conservation plans have identified Black Oystercatchers and Dunlins as priorities for management, particularly for the northern Pacific coast of North America, due to the Black Oystercatcher's small global population and specialized use of habitat, and the high proportion of the Pacific coast wintering population of Dunlins in western Washington. Populations of these two shorebird species appear to be stable. Puget Sound qualifies as an area of regional importance for Dunlins (and other shorebirds) according to criteria established by the Western Hemisphere Shorebird Reserve Network; a hemisphere-scale conservation plan is being developed for this species. Comprehensive research and monitoring strategies for the Black Oystercatcher are under development.

Preface

Puget Sound is home to many bird species closely associated with the marine environment (Johnson and O'Neil 2001). Because of this great species richness, it was necessary to limit the focus of this document to a manageable number of species accounts. For simplicity's sake, three primary habitats used by marine birds in Puget Sound were chosen: open water, rocky shoreline and open mud flats. The species associated with these habitats included in this document are Surf Scoter, Black Oystercatcher and Dunlin. For the purposes of this discussion, Puget Sound also includes the San Juan Islands.

These species are not intended to represent indicator species of these habitats because it is well known that other species found in Puget Sound use the areas differently (Johnson and O'Neil 2001). However, each species has been the focus of considerable research and is clearly linked to Puget Sound nearshore ecosystems. All three species occupy mid- to upper levels in the Puget Sound wildlife food web, each using fish or invertebrate food resources and all susceptible to predation by other species.

For a variety of reasons, each of these three species is an important component of the Puget Sound avifauna. All three species have value to the bird-watching community. Wildlife observation has become one of the most significant economic activities in Washington and elsewhere in North America (U.S. Department of Interior and U.S. Department of Commerce 2002, Caudill 2003, Washington Department of Fish and Wildlife and Washington Department of Community, Trade and Economic Development 2004). Because of their rather limited distribution along the coasts of North America, Surf Scoters are likely a species of interest to visiting bird-watchers. This species is also a candidate indicator of contaminant loads in the marine environment, as they often carry substantial burdens of heavy metals. Their populations are declining, and this is of concern to conservation and management agencies and interest groups.

As a group, shorebirds are some of the most popular birds among the bird-watching community. This popularity is due to a variety of factors, including their often bright or strongly contrasting plumage and bill color (Black Oystercatcher), their striking calls and behavior, their large concentrations and visibility of migrations (Dunlins), and the dramatic means they employ to evade falcon predators. National and regional conservation plans have identified both species as management priorities, particularly for the northern Pacific coast of North America (Brown et al. 2001, Drut and Buchanan 2000). There are two reasons for these designations. First, due to a very small global population and specialized use of habitat, the Black Oystercatcher is vulnerable to factors that could impact its population. Numerous research projects involving this species are ongoing, and efforts are under way to conduct comprehensive surveys to better understand the species' status (Elliott-Smith et al. 2006). Second, although much more abundant than the Black Oystercatcher, the majority of wintering Dunlins in North American occur between southern British Columbia and northern California (Warnock and Gill 1996). This aggregation of Dunlins places great importance on the region as both a wintering area and a network of sites considered critical to the birds while they accumulate fat deposits necessary to fuel a lengthy and physiologically expensive migration to coastal Alaska and beyond (Warnock and Gill 1996). As a complex of estuaries, Puget Sound qualifies as an area of regional importance according to criteria established by the Western Hemisphere Shorebird Reserve Network (Drut and Buchanan 2000; see Harrington and Perry 1995). A hemisphere-scale conservation plan is being developed for this species (Guillermo Fernández, personal communication).

Nearshore Habitat Requirements

Distribution, life histories, habitats, and key stressors

Among the seven habitats associated with coastal and marine environments in Washington and Oregon that were identified by Johnson and O'Neil (2001), bays/estuaries and inland marine waters are most clearly represented in Puget Sound (Buchanan et al. 2001). Although other marine habitats are also found in Puget Sound (e.g., beaches, headlands), most species associated with those habitats are found only on the outer coast and generally do not occur in Puget Sound. Numerous bird species are either closely or generally associated with bays and estuaries or inland marine waters in Washington and Oregon (Buchanan et al. 2001) and occur in Puget Sound (Wahl et al. 2005; Appendix 1). Many of these species have annual migrations or dispersal movements exceeding 1,000 km (Buchanan et al. 2001).

Surf Scoter: *Melanitta perspicillata*

The Surf Scoter is a conspicuous member of the waterfowl community in marine waters of western Washington. It is one of the more abundant diving ducks in Puget Sound and was the most abundant scoter encountered in Puget Sound aerial surveys during the 1990s (Nysewander 2005a). Mean densities in nearshore waters during the 1990s ranged from 55 to 70 birds/km^2, and highest densities were between 250 and 1,000 birds/km^2 (Nysewander 2005a). High counts of Surf Scoter flocks in 1978-1979 exceeded 20,000 birds in the Strait of Georgia (Wahl et al. 1981). Christmas Bird Count totals from Puget Sound sites in the 1990s ranged from 2,410 (Bellingham, 1996) to 4,774 (Oak Harbor, 1993) (Nysewander 2005a). Surf Scoters are most abundant in Puget Sound between September and May, where they are found at highest densities in southern and central Puget Sound (Nysewander et al. 2005). Surf Scoters are very uncommon in autumn and rare in winter in eastern Washington, occurring as singles or very small flocks (Nysewander 2005a). In short, at a population level, it is essentially dependent on marine waters during the non-breeding period.

Surf Scoters from Puget Sound wintering areas breed in northern Canada (Savard et al. 1998). Scoters equipped with transmitters migrated from Puget Sound between 20 March and 12 May in 2004 (Nysewander et al. 2004). Numerous spring migrants remained in Puget Sound or the Strait of Georgia, while a smaller proportion visited Southeast Alaska before moving to the northern interior breeding areas (Nysewander et al. 2004, 2005). Breeding areas used by Puget Sound scoters included northern Saskatchewan and the Northwest Territories, primarily in the general vicinity of Great Slave, Great Bear and Athabaska lakes (Nysewander et al. 2004).

Following the breeding season, Surf Scoters move away from breeding areas to molt (Nysewander et al. 2004). Whereas some Surf Scoters disperse to coastal Alaska and molt there, others return to Puget Sound, the Strait of Georgia or the Oregon coast before molting (Nysewander et al. 2004, 2005). Autumn migrants begin returning to Puget Sound between July (males) and August-September (females) (D. Nysewander, personal communication).

In marine environments, the Surf Scoter is strongly associated with shallow nearshore waters. Information from Puget Sound indicates that most Surf Scoters use waters less than 18 meters (about 60 feet) deep (D. Nysewander, personal communication). In coastal British Columbia and Washington, Surf Scoters occur farther offshore and in deeper water at night than during diurnal periods (Lewis et al. 2005; D. Nysewander, personal communication). Although there are generally no differences in habitat use according to age or sex, first-year males in coastal British Columbia tended to use areas with lower exposure to winds and waves (Iverson et al. 2004). In Southeast Alaska, Surf Scoters used shallow water areas around islands and near entrances to glacial inlets while molting (Butler 1998). Although Surf Scoters molt in Puget Sound (Nysewander et al. 2004, 2005), and these areas tend to be associated with significant eelgrass habitat, the specific attributes of these areas have not been described.

Surf Scoters had been thought to have a rather narrow diet in the marine environment, but now it appears that they utilize several different foraging strategies. At certain times bivalves dominate the diet (Vermeer 1981, Savard et al. 1998, Lacroix et al. 2004), especially clams and mussels (D. Nysewander, personal communication). Surf Scoters in some areas are known to extract shellfish from commercial operations (D. Nysewander, personal communication). In spring, perhaps 50 percent of Surf Scoters in the region will feed on herring eggs when available (D. Nysewander, personal communication), and flocks of scoters regularly track the northward progression of spawning events (Vermeer 1981). Surf Scoters appear to use a wide variety of invertebrates (e.g. shellfish, amphipods) associated with eelgrass habitats used in late summer (D. Nysewander, personal communication). These latter food habits have not been closely examined. Surf Scoters forage throughout the day and night, and typically procure food by diving, although diving is rare during nocturnal periods (Lewis et al. 2005).

Population trends are well documented based on surveys conducted in Puget Sound. Surveys conducted between 1992 and 1999 indicate a 58 percent reduction in density indices of all three scoter species (combined) since 1978-1979 (Nysewander et al. 2005). Data from the recent monitoring efforts do not indicate a clear trend in abundance since the early 1990s, as densities in 2002 (about 45/km^2) were similar to those in 1994 (about 50/km^2) but far below those in

1995 (about 70/km^2) (Nysewander et al. 2005). Looking at areas within Puget Sound, scoter abundance (all three species combined) apparently declined since the early 1990s in the Whidbey/Camano and south Puget Sound survey areas, and perhaps in Hood Canal; scoter densities appeared stable in central and northern Puget Sound survey areas (Nysewander et al. 2005). Although the analysis reported immediately above involved all three scoter species combined, additional data indicate that, compared to the other two scoter species, Surf Scoters are a) more abundant in Puget Sound, b) more reliant on herring spawning events, and c) declining in other parts of their range along the Pacific coast of North America (D. Nysewander, personal communication).

Declines in abundance have been noted in other parts of the Surf Scoter's distribution in western North America. In Prince William Sound, Alaska, numbers dropped by >50 percent between 1972 and the early 1990s; changes in populations of forage fish associated with increasing water temperatures in the northeastern Pacific Ocean were suggested as a possible factor influencing the change in scoter abundance (Agler et al. 1999). A decline in abundance was also noted between 1974 and 1993 at Southeast Farallon Island, California (Pyle and DeSante 1994), although populations at Tomales Bay, California, appeared to be stable between 1989 and 1996 (Kelly and Tappen 1998).

The potential causes of population change in Surf Scoters, although not definitively identified, include changes in food resources and heavy metal contaminants. Declines in herring stocks have coincided with Surf Scoter population changes in Puget Sound (D. Nysewander, personal communication). Studies looking at fat reserves, body mass and stable isotopes indicate that Surf Scoters that feed at herring spawning events are heavier and in better physical condition when northward migration begins (Anderson et al. 2005). Given that such a large proportion of Surf Scoters appears to track herring spawning events (perhaps 50%), a reduction in this resource could have fitness consequences that influence survival or productivity.

A possibly significant stressor for this species appears to be accumulation of heavy metal contaminants in tissues. Levels of cadmium in Surf Scoters from the Pacific Northwest are generally high (Henny et al. 1991), and in the Queen Charlotte Islands, British Columbia, the levels exceed those thought to cause kidney damage (Barjaktarovic et al. 2002). The high levels documented in British Columbia reflected local high concentrations of cadmium contaminants in that area (Barjaktarovic et al. 2002). In the Queen Charlotte Island study, males had higher levels of cadmium and zinc than females (Barjaktarovic et al. 2002). Surf Scoters in San Francisco Bay, California, also carried elevated burdens of cadmium that indicated chronic exposure (Scheuhammer 1987, Ohlendorf et al. 1991).

Selenium is another potentially harmful metal found in tissues of Surf Scoters. Selenium has been found in high concentrations in Surf Scoters in coastal Califonia, and an increase in concentrations in birds over winter indicated local acquisition (Savard et al. 1998). Surf Scoters at Suisun Bay, California, had concentrations of hepatic selenium and mercury at levels thought to impair reproduction and neurological function in experiments with Mallards (*Anas platyrhynchos*; Hoffman et al. 1998). The toxic effects of selenium and other heavy metals on Surf Scoters are not understood (Ohlendorf et al. 1986).

Because of their strong association with marine waters, Surf Scoters, like other diving ducks in Puget Sound, are vulnerable to oil spills (Vermeer and Verneer 1975, Savard et al. 1998). Surf Scoters were impacted (fouled plumage or actual mortality) in several well-publicized spills that oiled dozens of birds (Kittle et al. 1987, Ford et al. 1991, Tenyo Maru Trustees 1993). Despite this vulnerability, very little information is specifically available related to incidents of fouling or mortality from oil spills. Numerous oil refineries and shipping channels used by seagoing vessels are situated at or near areas of substantial aggregations of Surf Scoters, indicating the potential for impacts to this and other species, should a spill occur.

Black Oystercatcher: *Haematopus bachmani*

The Black Oystercatcher, one of the largest shorebirds found in Washington, is a permanent resident of the immediate marine shoreline from the Aleutian Islands, Alaska, to Baja California, Mexico (Paulson 1993). Throughout this distribution, it is found at low densities, most often seen in pairs or small groups; larger groups (i.e., >20) are regularly encountered outside the breeding season, when territories are not maintained, and a flock of 150 birds has been recorded (Andres and Falxa 1995). In Washington, Black Oystercatchers are slightly more common on the outer coast than in Puget Sound, and within Puget Sound they are generally restricted to the San Juan Islands and the eastern Strait of Juan de Fuca (Nysewander 2005b). In 2004-2005 nearly 200 Black Oystercatchers (71-74 nesting territories and 50 nonbreeders) were found during dedicated surveys in northern Puget Sound (San Juan Islands, Bellingham Bay, and Deception Island-northern Whidbey Island area; Nysewander et al. 2006). Black Oystercatchers are not considered migratory in this area, but the suspected departure of birds from southeastern Alaska before the onset of winter suggests that some northern birds may occasionally visit coastal Washington (Andres and Falxa 1995). Black Oystercatchers are completely dependent on the marine environment in all seasons.

The habitat requirements of Black Oystercatchers differ for nesting and foraging purposes. Nests are typically located on gradually sloping sand beaches (usually <15 degree slope) or rock benches located above the high tide zone, on islands, small islets (Andres 1998, Andres and Falxa 1995) and rocky headlands, although the latter are not used in Puget Sound (Nysewander 1977). Although most nest

scrapes are fully exposed, some are situated adjacent to sparse vegetation (Andres and Falxa 1995). Black Oystercatchers often roost in breeding areas (Andres and Falxa 1995). Foraging habitat is characterized by exposed rocky or sandy shoreline below the high tide line; sand beaches used by oystercatchers often have substantial deposits of shell and gravel (Andres 1998, Andres and Falxa 1995, Nysewander 1977). Foraging habitat is often situated near nesting areas.

The breeding biology of Black Oystercatchers has been well studied, particularly in Alaska and British Columbia. Black Oystercatchers typically lay one-three eggs; in Alaska, modal clutch size was three, and mean size of initial clutches was 2.42, the occasional subsequent clutch being slightly smaller (Andres and Falxa 1995; see Tessler et al. 2006). In a comprehensive analysis of data from Alaska and British Columbia, the fledging rate per pair was 0.32 (Tessler et al. 2006). Eggs are laid in shallow scrapes on the ground (Andres and Falxa 1995). In Washington, nests laid in scrapes with egg-sized pebbles had higher egg survival rates than other nests (Nysewander 1977). Some birds exhibit strong site fidelity to breeding areas (L'Hyver and Miller 1991, Morse and Powell 2006), and site fidelity is stronger at territories where birds nested successfully in previous years compared to territories where previous nesting attempts failed (Hazlitt and Butler 2001). Hatching success and annual reproductive success vary geographically and from one year to the next (Andres and Falxa 1995). For example, a recent study in British Columbia found that only 7 of 30 pairs present on territories in each of two successive years raised young in both years; 16 pairs failed to nest in both years (Hazlitt and Butler 2001). Substantial numbers of oystercatchers (27-34%) were floaters (i.e., non-breeders) at Middleton Island, Alaska, in 2004 and 2005 (Guzzetti et al. 2006). Hatching success at nests monitored by video cameras was higher (82%) than at nests that were not monitored (32%), suggesting that some estimates of productivity may be inaccurate (Spiegel et al. 2006).

Geophysical features at nesting areas appear to influence reproductive output. For example, Hazlitt (2001) reported greater hatching and productivity from nests in shallow sloping sites than at sites on steeper slopes. In addition, rates of food provisioning of chicks by adults were higher on shallow sloping sites than on sites on steeper slopes (Hazlitt et al. 2002).

Black Oystercatchers forage on a variety of intertidal invertebrates. Food items from the northeastern Pacific coast include various mussels, limpets, whelks, crabs, chitons, urchins, barnacles and polychaetes (Andres and Falxa 1995). A study of food use in Prince William Sound, Alaska, indicated that birds made far greater use of some food sources in certain nesting habitats compared to others: chitons (48%) and limpets (40%) on exposed rocky shoreline, clams (59%) on sheltered shorelines, bay mussels (33%) and limpets (47%) on mixed sand and gravel beaches, and limpets (82%) on cobble beaches (Andres and Falxa 1995). In British Columbia, limpets, usually those <20 mm in length, were the primary food for chicks (Hazlitt et al. 2002).

Black Oystercatchers directly affect the distribution, abundance and community structure of prey populations. Experiments in California demonstrated that territorial limpets (*Lottia gigantea*) were found primarily on vertical or nearly vertical surfaces, and did not occur on horizontal surfaces in areas where Black Oystercatchers were present. In contrast, survival rates of limpets translocated to horizontal surfaces at sites with oystercatchers were lower than at control sites (i.e., sites without oystercatchers), suggesting that oystercatchers preferentially removed limpets from such surfaces (Lindberg et al. 1998). Exclosure experiments on Tatoosh Island, Washington, showed that oystercatchers foraging in the lower intertidal zone directly reduced urchin abundance by 45-59 percent, which resulted in an increased algal cover by a factor of 24 (Wootton 1995).

Trend data for Black Oystercatchers in the region are lacking, but data from the breeding season separated by about two decades are informative. Surveys conducted between 1973 and 1980 in Puget Sound produced an estimate of at least 90 birds at 34 sites, while surveys of the same areas in 2000 found 79 birds at 35 sites (Nysewander 2005b). Those counts, however, did not represent a comprehensive estimate of the Puget Sound population (D. Nysewander, personal communication) and would not account for redistribution and movement; therefore, these data cannot be used to evaluate trends. Changes in the abundance of Black Oystercatchers have been noted in two areas with small breeding populations: an increase at Dungeness National Wildlife Refuge and a decline at Protection Island National Wildlife Refuge (Sanguinetti and Holcomb 2006). Preliminary data from Pacific Rim National Park, Canada, suggest population stability between 1970 and 2005 (Clarkson 2006).

Actual or potentially important limiting factors that have been identified include environmental conditions, predation threat, competition or disturbance by humans and environmental contamination. Because Black Oystercatchers often place their nests very near the high tide line, adverse weather events, especially those associated with high tides, may produce waves capable of washing over and destroying the contents of nests (Vermeer et al. 1992, Spiegel et al. 2006). Research at several study sites in Alaska and British Columbia indicates that tidal inundation was the single greatest cause of egg loss in 2005, accounting for more than 40 percent of such losses (Tessler et al. 2006).

Black Oystercatcher nests and chicks are exposed to numerous predators, including gulls (*Larus* spp.), crows (*Corvus* spp.), raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), American mink (*Mustela vison*), river otter (*Lutra canadensis*), red fox (*Vulpes vulpes*) and domestic cats (*Felis domesticus*) (Andres and Falxa 1995). The potential significance of mammalian predators was indicated when Vermeer et al. (1992) found lower fledging rates on islands accessible

to raccoons than at other sites. Similarly, densities of Black Oystercatchers were higher on islands from which red foxes had been removed compared to islands with no removal (Byrd et al. 1997). Although Vermeer et al. (1992) found no detrimental effect of gull presence on fledging success of Black Oystercatchers, other studies indicated lower nest success or smaller clutch size at nests near gull colonies (Nysewander 1977, Hazlitt 2001). Data from a small sample of nests at Dungeness National Wildlife Refuge indicate higher productivity at nests with more Bald Eagles and fewer Glaucous-winged Gulls (Sanguinetti and Holcomb 2006). Bald Eagles and Peregrine Falcons are capable of capturing Black Oystercatchers, and predation by the latter species has been recorded, but predation of adults by these species is probably rare (Andres and Falxa 1995). Predator presence is thought to negatively influence Black Oystercatcher productivity (Nysewander personal communication) but such interactions have not been evaluated in Washington. In addition, pinnipeds may crush eggs or chicks when they haul out at nesting areas (Warheit et al. 1984).

Human activity has the potential to disturb Black Oystercatchers in nesting and foraging areas. Human presence in these areas may influence behavior or occurrence patterns (Warheit et al. 1984), although this type of disturbance has not been evaluated in Washington. In California, Lindberg et al. (1998) found that humans exploit the limpet *L. gigantea* and reduce its populations to low levels. Given the importance of limpets in the diet of Black Oystercatchers, it seems likely that high levels of human exploitation of this resource could influence oystercatcher occurrence. In contrast, Black Oystercatcher numbers have declined substantially at Protection Island National Wildlife Refuge since the 1980s, when the refuge was closed to human visitors (Sanguinetti and Holcomb 2006); this suggests that a factor other than human disturbance has influenced oystercatcher abundance. Morse and Powell (2006) reported that human disturbance in Kenai Fjords National Park, Alaska, influenced breeding behavior of individuals but did not adversely affect population dynamics.

Because of their strong association with marine shorelines, Black Oystercatchers are potentially vulnerable to the effects of oil spills. Research in Alaska following the Exxon Valdez spill indicates the effect of spills was temporally variable. Black Oystercatchers foraged less in contaminated areas than in oil-free areas (Andres 1999). One study found that effects of oil presence were negligible and masked by egg loss and chick predation (Andres 1999). Chicks hatched and raised in oiled areas accumulated mass more slowly than chicks from oil-free areas, but this difference did not result in lower fledging success (Andres 1999). In another study, nest success of Black Oystercatchers was impacted by oiling, but no oil effect was evident on nesting effort, breeding phenology, egg volume, chick growth rates or chick survival (Murphy and Mabee 2000). Another investigation reported negative effects of the oil spill in 1990 and 1991, but not in 1993, 1996 or 1998 (Irons et al. 2000).

Dunlin: *Calidris alpina*

The Dunlin breeds across much of the Arctic (Warnock and Gill 1996) and the *C. a. pacifica* subspecies is found in marine estuaries throughout Puget Sound and the outer Washington coast during the non-breeding period (Buchanan 2005a). Dunlins typically return from the breeding grounds in mid- to late October (Paulson 1993), and from that time through mid-April, they generally make up more than 90 percent of the estuarine shorebird community (Buchanan and Evenson 1997, Evenson and Buchanan 1997). The peak of spring migration occurs in late April or very early May, and essentially all migrants have departed by about mid-May (Buchanan 2005a). Although Dunlins in some areas in western Washington use non-marine habitats (e.g. agricultural areas), many birds make substantial or nearly exclusive use of tide flats in marine estuaries.

The abundance of Dunlins varies from year to year, and there are substantial differences in abundance within Puget Sound. Winter and spring surveys of more than 60 estuaries in Puget Sound in the early 1990s indicated substantial differences in total counts for all sites combined in winter (50,143-78,792) and spring (33,540-67,677), with annual differences by factors of up to eight in spring and 29 in winter for the four sites with the highest totals (Evenson and Buchanan 1997). The highest counts in all seasons were consistently recorded from four sites in northern Puget Sound (Padilla Bay, Port Susan Bay, Samish Bay and Skagit Bay); highest counts at these sites ranged between 11,550-31,037 in winter and 11,167-35,000 in spring (Evenson and Buchanan 1997). Seventeen other sites have supported at least 1,000 birds in at least one season, the most prominent being Chuckanut Bay, Drayton Harbor, Dungeness Bay, Sequim Bay and Totten Inlet (Buchanan 1988, Evenson and Buchanan 1997; see Table 1). Sites in Hood Canal supported the lowest abundance of Dunlins in any season (Evenson and Buchanan 1997).

Dunlins are typically associated with estuarine tide flats during their residence in western Washington. Preferred foraging areas are characterized by the presence of fine silts (Warnock and Gill 1996). Tide flats with a high sand content may occasionally be used, but such areas do not regularly support large numbers of birds (Paulson 1993, Johnson and O'Neil 2001). Beaches with fine cobble tend not to be used as foraging locations. Dunlins will forage in flooded agricultural fields during high tides. During high tides Dunlins roost in a variety of areas including exposed spits, low salt marsh, open agricultural fields, floating docks and log rafts (and emergent logs), and occasionally on breakwaters. On rare occasions, Dunlins will not roost at high tide, despite the apparent availability of suitable roosting areas, and instead engage in continuous flight until mud is exposed on the subsequent falling tide (Brennan et al. 1985).

Dunlins forage on a wide variety of benthic invertebrates by probing with their long bills in tidal mudflats. The only study on food habits in Puget Sound found that Dunlins consumed a variety of invertebrates, including unidentified polychaete worms and several arthropods including *Pancolus californiensis*, *Corophium insidiosum*, and *Corophium salmonis* (Brennan et al. 1990). Prey availability varied among sites (Buchanan et al. 1985), and at one site (Totten Inlet), Dunlins used polychaete worms in proportion to their abundance (Brennan et al. 1990). Recent rapid inventories at selected estuaries in western Washington indicate the presence of numerous exotic invertebrates (Cohen et al. 2001; see also Cordell and Morrison 1996); it is unknown if these species have altered the invertebrate community structure or become important food for Dunlins.

The body mass of Dunlins changes dramatically throughout the season. Autumn migrants typically deposit fat reserves prior to the beginning of winter. Over the course of the winter, the typical pattern is for individual birds to slowly lose weight. This weight reduction is thought to be an intentional response to the conflicting needs of obtaining enough food in a season of potentially high energetic costs while maintaining an optimal weight to maximize agility when under attack by falcon predators (Evans 1976, Dugan et al. 1981). Body mass is lowest in late winter, and then the birds gradually begin accumulating mass until mid- or late spring, when mass is accumulated more rapidly (McEwan and Whitehead 1984). Dunlins at two of three Puget Sound study sites (Nisqually River estuary, Samish Bay) exhibited the expected overwinter mass change pattern; at the third site (Totten Inlet), body mass actually increased over the course of the winter (Buchanan et al. 1985). Dunlins increase their body mass very dramatically in the spring (McEwan and Whitehead 1984) to fuel migratory flights to the Copper River delta and other migration stopover sites in Alaska (Warnock and Gill 1996). An inability to accumulate appropriate fat deposits prior to migration can influence survival during migration or after arrival at or near breeding areas, and may reduce reproductive success (Davidson and Evans 1989).

Movements by Dunlins within the winter season have been well documented using radio telemetry in coastal areas of British Columbia and California. Movements documented in British Columbia include flights between foraging (including non-tidal areas) and roosting areas (Butler 1994). Movements in California include flights of up to 160 km from a coastal estuary to an inland area where birds remained for multiple tidal periods before returning to the outer coast (Warnock et al. 1995). Movements in western Washington have been observed and also inferred from count data. For example, during winter shorebird counts from a small plane in northern Puget Sound, small flocks of Dunlins were seen flying low over the water 10 km or more from shore. Similarly, shorebird flocks often fly 10 km or more from a foraging area to a suitable roost site (Brennan et al. 1985; J. Buchanan, unpublished data). In addition, mid-winter counts, conducted both before and after a major cold spell that created a covering of ice over many foraging areas, indicated departure from the area by thousands of birds that later returned when conditions improved (Evenson and Buchanan 1997).

Table 1. High counts (only those of at least 1,000 birds are shown) of Dunlins at Puget Sound sites that supported at least 1,000 Dunlins in winter or spring (data from Buchanan 1988, Evenson and Buchanan 1997).

Site	Winter	Spring
Northern Puget Sound		
Ala Spit	1,100	
Bellingham Bay	1,920	
Birch Bay	3,000	
Chuckanut Bay		4,600
Drayton Harbor	6,320	1,781
Fidalgo Bay	2,658	3,579
Lummi Bay	3,850	1,442
Padilla Bay	11,500	12,339
Port Susan Bay	31,037	35,000
Samish Bay	15,000	12,973
Skagit Bay	29,255	11,167
Snohomish River estuary	4,200	1,848
Central and Southern Puget Sound		
Eld Inlet	2,100	1,500
Nisqually River estuary	2,400	
Sinclair Inlet	1,000	
Totten Inlet	4,500	5,100
Hood Canal		
Annas Bay	1,378	
Strait of Juan de Fuca and Admiralty Inlet		
Crockett's Lake	1,200	
Dungeness Bay	2,206	1,386
Port Angeles Harbor	1,771	
Sequim Bay	4,640	1,905

Dunlins are common to abundant throughout estuarine areas of Puget Sound (Buchanan 2005a). Population trends for this species are not well understood although some believe they are declining (e.g., Paulson 1993). The data to support

such statements are lacking or incomplete (Paulson 1993) or refer to populations in other parts of North America (Morrison et al. 2001), and information from the northern Pacific coast does not currently suggest that a population decline has occurred (J. Buchanan, unpublished data).

A number of environmental, ecological or human-related factors are thought or known to influence the physical condition of Dunlins. After the Rock Sandpiper (*Calidris ptilocnemis*), the Dunlin has the northernmost winter distribution of any shorebird along the Pacific coast of North America. Despite its hardy nature, however, research in coastal Europe has shown that cold weather or strong winds can result in reduced physical condition and that particularly severe weather events may cause mortality (Clark 1982). Although similar research has not been conducted in western Washington or elsewhere in North America, winter weather conditions almost certainly influence body condition of Dunlins, and some weather-related mortality may occur in years with particularly severe weather events, such as the winter of 1990-1991 (see Evenson and Buchanan 1997).

While maintaining adequate body mass, Dunlins must also avoid capture by Peregrine Falcons (*Falco peregrinus*) and Merlins (*Falco columbarius*), two falcon predators that actively seek, capture and consume Dunlins in coastal Washington (Buchanan et al. 1986, 1988). Although the relationship between Dunlins and these falcons might, upon first glance, be considered "in balance," it has been suggested, for example, that Western Sandpiper (*Calidris mauri*) behavior has changed in response to increasing populations of Peregrine Falcons (Ydenberg et al. 2004). Peregrine Falcons and Merlins are now well represented in marine estuaries (Anderson and Herman 2005, Gleason et al. 2005), and comprehensive investigations of the relationships of these falcons and Dunlins have not been conducted when populations of both falcon species were stable and healthy.

It is against this backdrop of environmental and ecological stressors that human-related impacts have the potential to disproportionately influence the health of Dunlin populations. Included in this latter category of potential impacts are loss and degradation of habitats, exposure to environmental contaminants (including oil contamination), and the effects of exotic plant and invertebrate species (Buchanan 2000, Drut and Buchanan 2000, Buchanan 2005b). Although wetland loss has likely influenced the magnitude of overwintering Dunlin populations in Puget Sound, as has been demonstrated elsewhere (for review, see Buchanan 2000), most of the loss or degradation appears to have occurred decades ago. The most important losses or changes to important habitats include dike building and conversion of estuarine wetlands. Some of these modified estuaries (e.g., Port Susan Bay, Skagit Bay) currently support large aggregations of Dunlins, whereas others (e.g., Budd Inlet, Commencement Bay, Elliott Bay) no longer (or rarely) support Dunlin flocks. Although many of the assumed impacts to Dunlin populations have already occurred, future conversion of habitat would likely result in negative responses by shorebirds due to reductions in foraging areas and subsequent density-dependent changes in body condition (Evans 1976, Sutherland and Goss-Custard 1991).

Environmental contaminants are a threat to Dunlin populations in the Puget Sound region, although the likelihood of a significant impact is unknown. Puget Sound is home to several oil refineries and industrial ports that attract high levels of shipping traffic (Buchanan 2000, Drut and Buchanan 2000). An oil spill near any of the estuaries supporting large aggregations of Dunlins could result in direct mortality through oiling or in reduced body condition of Dunlins that are forced to move to other estuaries; reduced body condition would be expected as a result of increased densities of birds competing for limited resources (Evans 1976, Sutherland and Goss-Custard 1991). Although chemical contaminants in Dunlins were found at low levels in the early 1980s (Schick et al. 1987), the presence of heavy metals was documented at levels that were of concern (Custer and Myers 1990), and local application of agricultural chemicals likely resulted in the deaths of more than 200 Dunlins in a single flock at an agricultural area adjacent to northern Puget Sound (Buchanan 2000).

Various species of exotic cordgrasses (*Spartina* spp.) are now found in several estuaries on the Pacific coast of North America (Daehler and Strong 1996). Simple models indicate that most estuaries between northern California and Puget Sound are vulnerable to cordgrass invasion (Daehler and Strong 1996). *Spartina* has the potential to grow rapidly in estuaries and form large "meadows" of marsh in areas that were formerly exposed tide flats. These areas of cordgrass marsh trap sediments and, as a consequence, raise the elevation of tidal flats. These two outcomes of cordgrass presence in this region result in a reduction of foraging habitat for shorebirds and other species. In Willapa Bay, Washington, *Spartina alterniflora* completely covered most of the areas that supported the largest aggregations of shorebirds in the bay less than one decade earlier (Buchanan 2003). Four species of cordgrass (*S. alterniflora, S. anglica, S. densiflora, and S. patens*) have been documented in northern Puget Sound (Daehler and Strong 1996; K. Murphy, personal communication).

Exotic invertebrates have been documented in estuaries throughout western Washington. Although systematic assessments have not been conducted, rapid surveys show the presence of many new species in Puget Sound estuaries (Cohen et al. 2001). The influence of these exotic species on Dunlin populations in Washington is unknown, but exotic invertebrates have been known to substantially alter the structure of invertebrate communities in other Pacific coast estuaries (Grosholz et al. 2000).

Ecosystem Processes Affecting Nearshore Birds

Although the cause of the Surf Scoter's recent population decline is not established, two factors seem the most likely candidates, and management to address these factors will likely benefit this and other nearshore species in Puget Sound. These factors are: a) effects of environmental contaminants, and b) reduction in food resources (Figure 1). Surf Scoters (and certain other waterfowl species) accumulate heavy metals at concentrations known to have physiological effects on birds in laboratory experiments. A high proportion of the Surf Scoter population appears to track annual herring spawning events, and birds associated with these events experience body mass increases prior to migration. Reduction of heavy metal contaminants in Puget Sound sediments would result in more healthy conditions for Surf Scoters and many other species (including humans). Similarly, more robust populations of food resources may result in increased physical condition, annual survival and productivity.

A number of management actions could improve conditions that may lead to increased survival or reproduction by Black Oystercatchers (Figure 2). Potentially valuable management actions include implementation of programs to reduce the risk or effects of oil spills, protection or restoration of rocky shoreline areas, and reduction of adverse human interactions in areas of suitable habitat. These changes should restore or protect nearshore processes that would then result in more and higher-quality food resources and nesting areas for this species.

The Dunlin has been the subject of more research than perhaps any other shorebird species in the world. For this reason, relationships between management actions and numerical or functional responses have been well established (Figure 3). Functional and numerical responses by Dunlins to management measures that have been documented in the scientific literature (via empirical studies and sophisticated models) include increased survival and reproduction, retention of body mass, and increased occurrence (see Buchanan 2000). Management measures that could improve conditions for Dunlins include wetland restoration, adequate recruitment of large logs in estuarine marshes, control of exotic vegetation (such as *Spartina* spp.), development of programs to reduce the risk or effects of oil spills, and reduction in effects of environmental contaminants such as oil and various chemical compounds. These actions should result in retention or enhancement of food resources and roost sites and minimize impacts of toxic compounds.

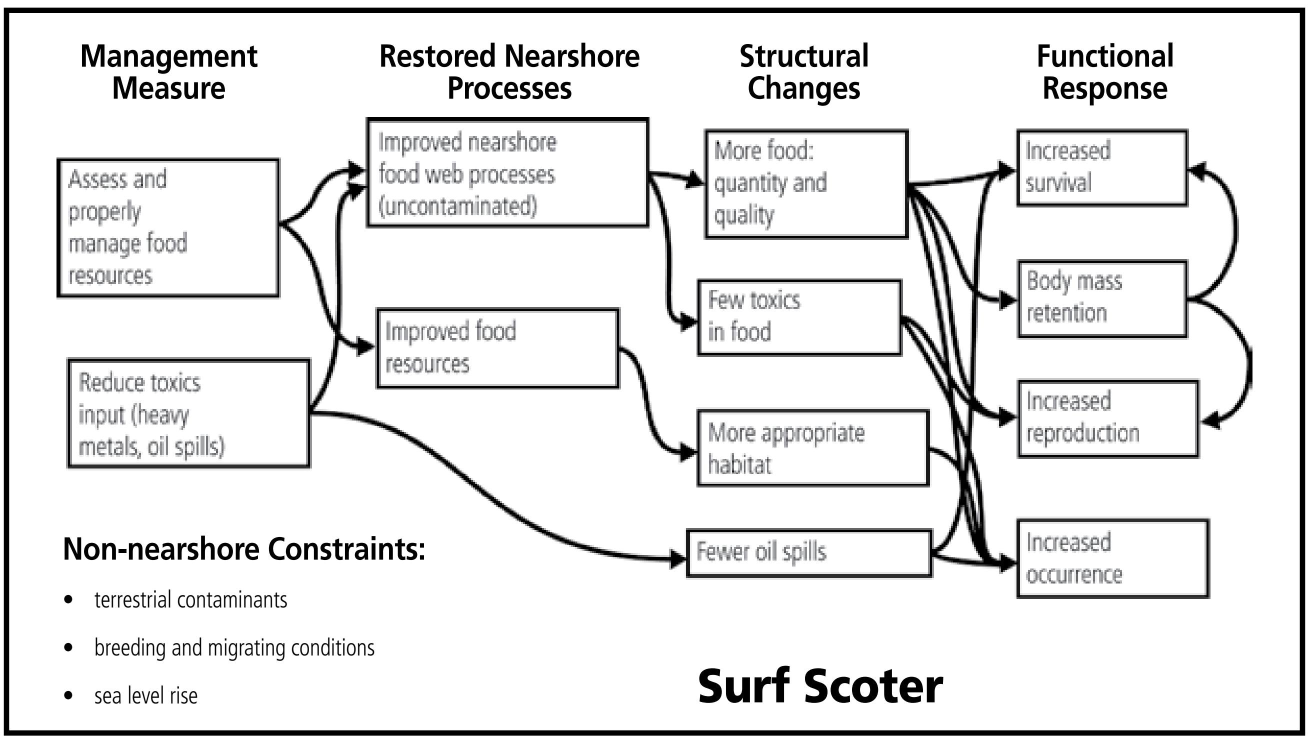

Figure 1. Conceptual model of linkages between Surf Scoters and nearshore restoration actions.

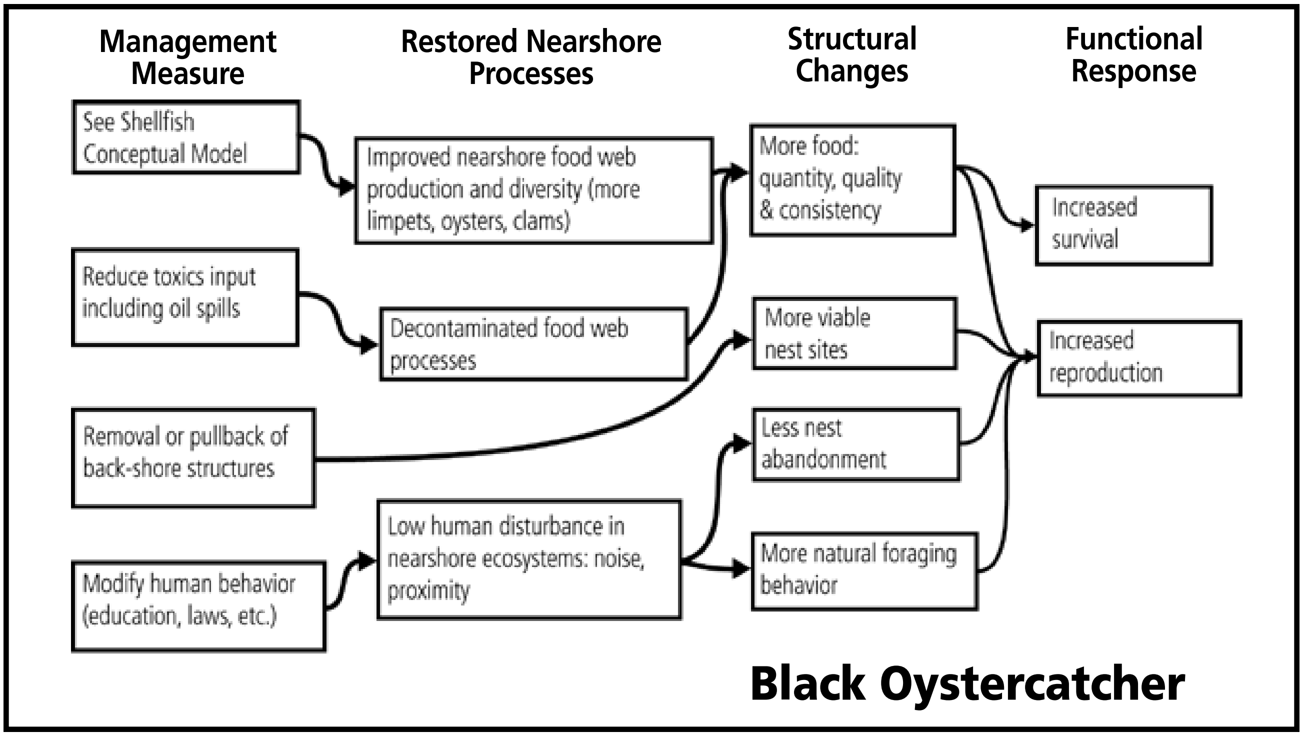

Figure 2. Conceptual model of linkages between Black Oystercatchers and nearshore restoration actions.

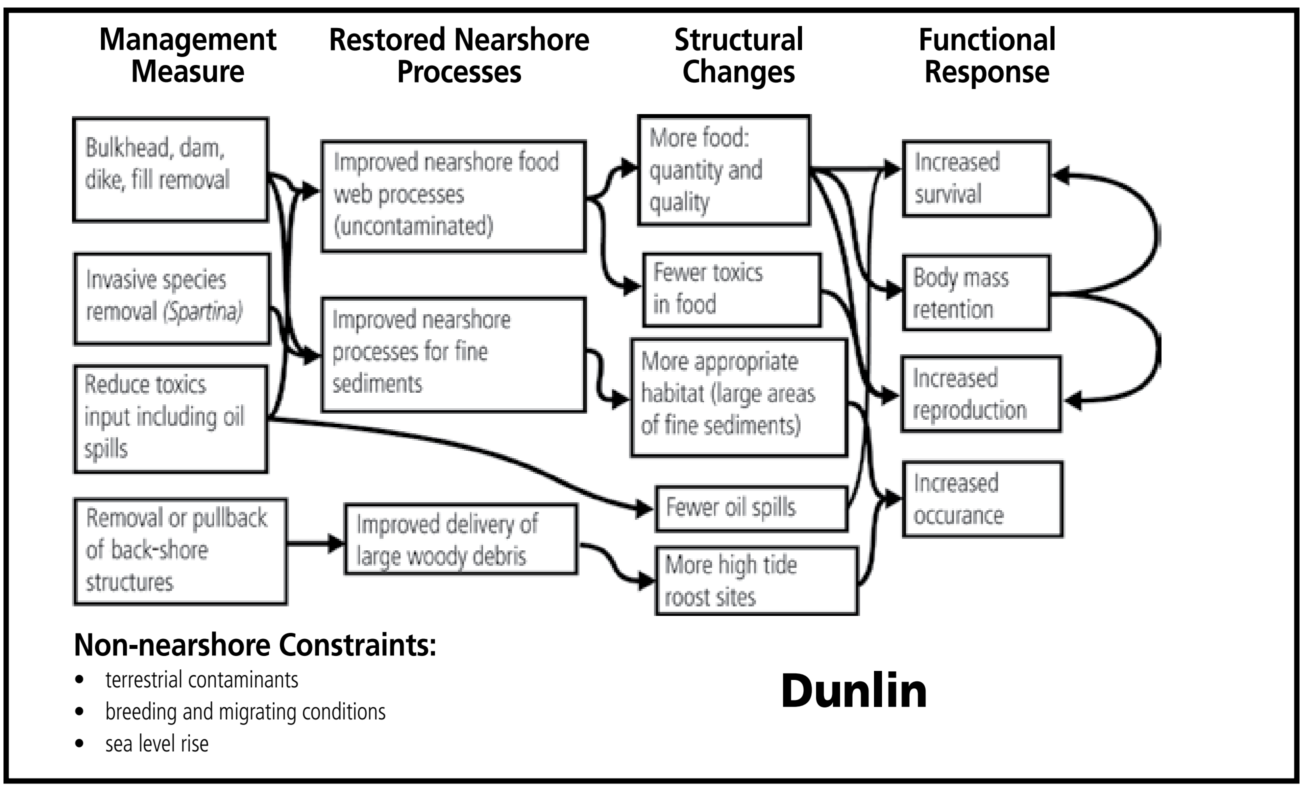

Figure 3. Conceptual model of linkages between Dunlin and nearshore restoration actions.

Critical Uncertainties

- What are the sources of heavy metal contaminants in Surf Scoters? In other words, does the accumulation of the contaminant burden occur in Puget Sound or in coastal Alaska or British Columbia — other areas visited by scoters between the breeding grounds and Puget Sound?
- Are heavy metal contaminants impairing Surf Scoter population performance, and if so, in what way(s)?
- Have changes in forage fish (i.e., herring) populations (or population structure) reduced food availability for Surf Scoters? If so, are these changes influencing scoter occurrence patterns or demography?
- Is Surf Scoter food availability influenced by exclusion from commercial shellfish operations?
- Have the recent increases in Bald Eagle and Peregrine Falcon populations in coastal areas forced Black Oystercatchers to adopt different responses to the presence of these potential predators? If so, do these responses impair reproductive output?
- Do humans significantly disturb Black Oystercatchers by boating or beach walking in sensitive areas (i.e., in nesting, roosting or foraging areas) in a way that influences occurrence or population performance?
- What is the current population status of the Black Oystercatcher?
- What is the current carrying capacity of Puget Sound for Dunlins? Can this carrying capacity be increased by wetland restoration, or is it limited by mud flat area?
- Is nutrient transport to tide flats compromised by diking of wetlands, or does increased delivery of sediments from upland areas compensate for this loss of wetland function in some way? Another way of asking this question is this: Will dike removal or similar restoration efforts measurably improve conditions for Dunlins?
- Do some sites lack the capacity to support higher densities of Dunlins due to geophysical attributes that prevent sediments from accumulating (e.g., at estuaries like the Nisqually River that are exposed to strong currents, versus more protected estuaries)?
- Have invertebrate communities changed due to invasions of exotic invertebrates? If so, have these changes impacted (or have they the potential to impact) the marine invertebrate community and ultimately focal species like the Surf Scoter, Black Oystercatcher and Dunlin?

References

Agler, B.A., S.J. Kendall, D.B. Irons, and S.P. Klosiewski. 1999. Declines in marine bird populations in Prince William Sound, Alaska coincident with a climatic regime shift. Waterbirds 22:98-103.

Anderson, C.M. and S.G. Herman. 2005. Peregrine Falcon (*Falco peregrinus*). Pages 126-127 *in* T.R. Wahl, T.R., B. Tweit, and S.G. Mlodinow (eds). Birds of Washington: status and distribution. Oregon State University Press, Corvallis, Oregon.

Anderson, E.M., J.R. Lovvorn, D. Esler, W.S. Boyd, D.R. Nysewander, and J.R. Evenson. 2005. The value of herring spawning events to spring conditioning of scoters in the Puget Sound Georgia Basin. Abstract of presentation given at the 2005 Puget Sound Georgia Basin research conference, Seattle, Washington.

Andres, B.A. 1999. Effects of persistent shoreline oil on breeding success and chick growth in Black Oystercatchers. Auk 116:640-650.

Andres, B.A. 1998. Shoreline habitat use of Black Oystercatchers breeding in Prince William Sound, Alaska. Journal of Field Ornithology 69:626-634.

Andres, B.A. and G.A. Falxa. 1995. Black Oystercatcher (*Haematopus bachmani*). The Birds of North America 155:1-20.

Barjaktarovic, L., J.E. Elliott, and A.M. Scheuhammer. 2002. Metal and metallothionein concentrations in scoter (*Melanitta spp.*) from the Pacific Northwest of Canada, 1989-1994. Archives of Environmental Contamination and Toxicology 43:486-491.

Brennan, L.A., J.B. Buchanan, S.G. Herman, and T.M. Johnson. 1985. Interhabitat movements of wintering Dunlins in western Washington. Murrelet 66:11-16.

Brennan, L.A., M.A. Finger, J.B. Buchanan, C.T. Schick, and S.G. Herman. 1990. Stomach contents of Dunlins collected in western Washington. Northwestern Naturalist 71:99-102.

Brown, S., C. Hickey, B. Harrington, and R. Gill. 2001. United States shorebird conservation plan. Second edition. Manomet Center for Conservation Sciences, Manomet, Massachusetts.

Buchanan, J.B. 2005a. Dunlin (*Calidris alpina*). Pages 161-162 *in* Wahl, T.R., B. Tweit, and S.G. Mlodinow (eds). Birds of Washington: status and distribution. Oregon State University Press, Corvallis, Oregon.

Buchanan, J.B. 2005b. Priorities for implementation of the northern Pacific coast regional shorebird management plan. Pages 112-114 *in* C.J. Ralph, and T.D. Rich (eds). Bird conservation implementation and integration in the Americas: proceedings of the third international Partners in Flight conference. USDA Forest Service General Technical Report PSW-GTR-191.

Buchanan, J.B. 2003. *Spartina* invasion of Pacific coast estuaries in the United States: implications for shorebird conservation. Wader Study Group Bulletin 100:44-47.

Buchanan, J.B. 2000. Shorebirds: plovers, oystercatchers, avocets and stilts, sandpipers, snipes, and phalaropes. *In* J. Azerrad, E.M. Larsen, and N. Nordstrom (eds.). Management recommendations for priority bird species. Washington Department of Fish and Wildlife, Olympia, Washington.

Buchanan, J.B. 1988. The abundance and migration of shorebirds at two Puget Sound estuaries. Western Birds 19:69-78.

Buchanan, J.B., C.T. Schick, L.A. Brennan, and S.G. Herman. 1988. Merlin predation on wintering Dunlins: hunting success and Dunlin escape tactics. Wilson Bulletin 100:108-118.

Buchanan, J.B., L.A. Brennan, C.T. Schick, M.A. Finger, T.M. Johnson, and S.G. Herman. 1985. Dunlin weight changes in relation to food habits and available prey. Journal of Field Ornithology 56:265-272.

Buchanan, J.B. and J.R. Evenson. 1997. Abundance of shorebirds at Willapa Bay, Washington. Western Birds 28:158-168.

Buchanan, J.B., S.G. Herman, and T.M. Johnson. 1986. Success rates of the Peregrine Falcon (*Falco peregrinus*) hunting Dunlin (*Calidris alpina*) during winter. Raptor Research 20:130-131.

Buchanan, J.B., D.H. Johnson, E.L. Greda, G.A. Green, T.R. Wahl, and S.J. Jeffries. 2001. Wildlife of coastal and marine habitats. Pages 389-422 *in* D.H. Johnson, and T.A. O'Neil (managing directors). Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvallis, Oregon.

Butler, R.W. 1998. Moulting sites of sea ducks and other marine birds in Frederick Sound, southeast Alaska. Canadian Field-Naturalist 112:346-347.

Butler, R.W. 1994. Distribution and abundance of Western Sandpipers, Dunlins, and Black-bellied Plovers in the Fraser River estuary. Pages 18-23 *in* R.W. Butler, and K. Vermeer (eds.). The abundance and distribution of estuarine birds in the Strait of Georgia, British Columbia. Canadian Wildlife Service Occasional Paper No. 83.

Byrd, G.V., E.P. Bailey, and W. Stahl. 1997. Restoration of island populations of Black Oystercatchers and Pigeon Guillemots by removing introduced foxes. Colonial Waterbirds 20:253-260.

Caudill, J. 2003. 2001 national and state economic impacts of wildlife watching. Addendum to the 2001 national survey of fishing, hunting and wildlife-associated recreation. Report 2001-2. U.S. Fish and Wildlife Service, Washington, D.C.

Clark, N.A. 1982. The effects of the severe weather in December 1981 and January 1982 on waders in Britain. Wader Study Group Bulletin 34:5-7.

Clarkson, P. 2006. Black Oystercatchers as indicators of healthy rocky intertidal ecosystems — what can they tell us? Abstract of presentation given at Shorebird Science in the Western Hemisphere, 27 February-2 March 2006, Boulder, Colorado.

Cohen, A.N., H.D. Berry, C.E. Mills, D. Milne, K. Britton-Simmons, M.J. Wonham, D.L. Secord, J.A. Barkas, B. Bingham, B.E. Bookheim, J.E. Byers, J.W. Chapman, J.R. Cordell, B. Dumbauld, A. Fukuyama, L.H. Harris, A.J. Kohn, K. Li, T.F. Mumford, Jr., V. Radashevsky, A.T. Sewell, and K. Welch. 2001. Washington State exotics expedition 2000: a rapid survey of exotic species in the shallow waters of Elliott Bay, Totten and Eld Inlets, and Willapa Bay. Washington State Department of Natural Resources, Olympia, Washington.

Cordell, J.R. and S.M. Morrison. 1996. The invasive Asian copepod *Pseudodiaptomus inopinus* in Oregon, Washington, and British Columbia estuaries. Estuaries 16:629-638.

Custer, T.W. and J.P. Myers. 1990. Organochlorines, mercury, and selenium in wintering shorebirds from Washington and California. California Fish and Game 76:118-125.

Daehler, C.C. and D.R. Strong. 1996. Status, prediction and prevention of introduced cordgrass *Spartina* spp. invasions in Pacific estuaries, USA. Biological Conservation 78:51-58.

Davidson, N.C. and P.R. Evans. 1989. Prebreeding accumulation of fat and muscle protein by Arctic-breeding shorebirds. Proceedings of the International Ornithological Congress 19:342-352.

Drut, M.S. and J.B. Buchanan. 2000. U.S. National shorebird conservation plan: northern Pacific coast working group regional management plan. U.S. Fish and Wildlife Service, Portland, Oregon.

Dugan, P.J., P.R. Evans, L.R. Goodyer, and N.C. Davidson. 1981. Winter fat reserves in shorebirds: disturbance of regulated levels by severe weather conditions. Ibis 123:359-363.

Elliott-Smith, E., S. Haig, S. Thomas, and L. Kelly. 2006. Black Oystercatcher inventory and long-term monitoring across the southern half of the species range with initial steps focused in Oregon. Abstract of presentation given at Shorebird Science in the Western Hemisphere, 27 February-2 March 2006, Boulder, Colorado.

Evans, P.R. 1976. Energy balance and optimal foraging strategies in shorebirds: some implications for their distributions and movements in the non-breeding season. Ardea 64:117-139.

Evenson, J.R. and J.B. Buchanan. 1997. Seasonal abundance of shorebirds at Puget Sound estuaries. Washington Birds 6:34-62.

Ford, R.G., D.H. Varoujean, D.R. Warrick, W.A. Williams, D.B. Lewis, C.L. Hewitt, and J.L. Casey. 1991. Seabird mortality resulting from the Nestucca oil spill incident winter 1988-89. Report prepared for Washington Department of Washington by Ecological Consulting, Inc., Portland, Oregon.

Gleason, T., T.L. Fleming, and J.B. Buchanan. 2005. Merlin (*Falco columbarius*). Pages 123-125 *in* T.R. Wahl, B. Tweit, and S.G. Mlodinow (eds). Birds of Washington: status and distribution. Oregon State University Press, Corvallis, Oregon.

Grosholz, E.D., G.M. Ruiz, C.A. Dean, K.A. Shirley, J.L. Maron, and P.G. Connors. 2000. The impacts of a non-indigenous marine predator in a California bay. Ecology 81:1206-1224.

Guzzetti, B., V. Gill, E. Murphy, D. Tessler, and E. Wilner. 2006. Productivity, paternity, mate and site fidelity in Black Oystercatchers (*Haematopus bachmani*) on Middleton Island, Alaska. Abstract of presentation given at Shorebird Science in the Western Hemisphere, 27 February-2 March 2006, Boulder, Colorado.

Harrington, B. and E. Perry. 1995. Important shorebird staging sites meeting Western Hemisphere Shorebird Reserve Network criteria in the United States. U.S. Department of the Interior, Fish and Wildlife Service.

Hazlitt, S.L. 2001. Territory quality and reproductive success of Black Oystercatchers in British Columbia. Wilson Bulletin 113:404-409.

Hazlitt, S.L. and R.W. Butler. 2001. Site fidelity and reproductive success of Black Oystercatchers in British Columbia. Waterbirds 24:203-207.

Hazlitt, S.L. and A.J. Gaston. 2002. Black Oystercatcher natal philopatry in the Queen Charlotte Islands, British Columbia. Wilson Bulletin 114:520-522.

Hazlitt, S.L., R.C. Ydenberg, and D.B. Lank. 2002. Territory structure, parental provisioning, and chick growth in the American Black Oystercatcher *Haematopus bachmani*. Ardea 90:219-227.

Henny, C.J., L.J. Blus, R.A. Graves, and S.P. Thompson. 1991. Accumulation of trace elements and organochlorines by Surf Scoters wintering in the Pacific Northwest. Northwestern Naturalist 72:43-60.

Hoffman, D.J., H.M. Ohlendorf, C.M. Marn, and G.W. Pendleton. 1998. Association of mercury and selenium with altered glutathione metabolism and oxidative stress in diving ducks from the San Francisco Bay region, USA. Environmental Toxicology and Chemistry 17:167-172.

Irons, D.B., S.J. Kendall, W.P. Erickson, L.L. McDonald, and B.K. Brian. 2000. Nine years after the Exxon Valdez oil spill: effects on marine bird populations in Prince William Sound, Alaska. Condor 102:723-737.

Iverson, S.A., B.D. Smith, and F. Cooke. 2004. Age and sex distributions of wintering surf scoters: implications for the use of age ratio as an index of recruitment. Condor 106: 252-262.

Johnson, D.H. and T.A. O'Neil (Managing directors). 2001. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvallis, Oregon.

Kelly, J.P. and S.L. Tappen. 1998. Distribution, abundance, and implications for conservation of winter waterbirds on Tomales Bay, California. Western Birds 29:103-120.

Kittle, L.J., R. Burge, R. Butler, W. Cook, K. Fresh, M. Kyte, R. Lowell, R. Pease, D. Pentilla, A. Scholz, S. Speich, R. Steelquist, and J. Walton. 1987. The Washington State Department of Ecology marine resource damage assessment report for the Arco Anchorage oil spill, December 21, 1985, into Port Angeles Harbor and the Strait of Juan de Fuca. Report 87-4, Washington Department of Ecology, Olympia, Washington.

Lacroix, D.L., K.G. Wright, and D. Kent. 2004. Observations of above-surface littoral foraging in two sea ducks, Barrow's Goldeneye, *Bucephala islandica*, and Surf Scoter, *Melanitta perspicillata*, in coastal southwestern British Columbia. Canadian Field-Naturalist 118:264-265.

Lewis, T.L., D. Esler, W.S. Boyd, and R. Zydelis. 2005. Nocturnal foraging behavior of wintering Surf Scoters and White-winged Scoters. Condor 107:637-647.

L'Hyver, M.-A. and E.H. Miller. 1991. Geographic and local variation in nesting phenology and clutch size of the Black Oystercatcher. Condor 93:892-903.

Lindberg, D.R., J.A. Estes, and K.I. Warheit. 1998. Human influences on trophic cascades along rocky shores. Ecological Applications 8:880-890.

McEwan, E.H. and P.M. Whitehead. 1984. Seasonal changes in body weight and composition of Dunlin (*Calidris alpina*). Canadian Journal of Zoology 62:154-156.

Morrison, R.I.G., Y. Aubry, R.W. Butler, G.W. Beyersberger, G.M. Donaldson, C.L. Gratto-Trevor, P.W. Hicklin, V.H. Johnston, and R.K. Ross. 2001. Declines in North American shorebird populations. Wader Study Group Bulletin 94:34-38.

Morse, J.A., A.N. Powell, and M.D. Tetreau. 2006. Productivity of Black Oystercatchers: effects of recreational disturbance in a national park. Condor 108:623-633.

Murphy, S.M. and T.J. Mabee. 2000. Status of Black Oystercatchers in Prince William Sound, Alaska, nine years after the Exxon Valdez oil spill. Waterbirds 23:204-213.

Nysewander, D.R. 2005a. Surf Scoter (*Melanitta perspicillata*). Pages 52-53 *in* Wahl, T.R., B. Tweit, and S.G. Mlodinow (eds.). Birds of Washington: status and distribution. Oregon State University Press, Corvallis, Oregon.

Nysewander, D.R. 2005b. Black Oystercatcher (*Haematopus bachmani*). Pages 137-138 *in* T.R. Wahl, B. Tweit, and S.G. Mlodinow (eds.). Birds of Washington: status and distribution. Oregon State University Press, Corvallis, Oregon.

Nysewander, D.R. 1977. Reproductive success of the Black Oystercatcher in Washington state. Master's thesis, University of Washington, Seattle, Washington.

Nysewander, D., J. Evenson, and D. Kraege. 2005. Determination of breeding area, migration routes, and local movements associated with Surf and White-winged Scoter wintering in the inner marine waters of Washington State. Unpublished annual project summary, Washington Department of Fish and Wildlife, Olympia, Washington.

Nysewander, D., J. Evenson, and D. Kraege. 2004. Determination of breeding area, migration routes, and local movements associated with Surf and White-winged Scoter wintering in the inner marine waters of Washington State. Unpublished progress report, Washington Department of Fish and Wildlife, Olympia, Washington.

Nysewander, D.R., J.R. Evenson, B.L. Murphie, and T.A. Cyra. 2005. Report of marine bird and mammal component, Puget Sound Ambient Monitoring Program, for July 1992 to December 1999 period. Washington Department of Fish and Wildlife, Olympia, Washington.

Nysewander, D., R. Milner, T. Cyra, and J. Evenson. 2006. Baseline monitoring established for breeding territories of Black Oystercatchers 2000-2005 in the northern inner marine waters of Washington State, addressing repeatable minimum objectives, utilizing selected established and new techniques. Abstract of presentation given at Shorebird Science in the Western Hemisphere, 27 February-2 March 2006, Boulder, Colorado.

Ohlendorf, H.M., D.J. Hoffman, M.K. Sakai, and T.W. Aldrich. 1986. Embryonic mortality and abnormalities of aquatic birds: apparent impacts of selenium from irrigation drainwater. Science of the Total Environment 52:49-63.

Ohlendorf, H.M., K.C. Marois, R.W. Lowe, T.E. Harvey, and P.R. Kelly. 1991. Trace elements and organochlorines in Surf Scoters from San Francisco Bay, 1985. Environmental Monitoring and Assessment 18:105-122.

Paulson, D. 1993. Shorebirds of the Pacific Northwest. University of Washington Press, Seattle, Washington.

Pyle, P. and D.F. DeSante. 1994. Trends in waterbirds and raptors at southeast Farallon Island, California, 1974-1993. Bird Populations 2:33-43.

Sanguinetti, P. and N. Holcomb. 2006. Black Oystercatcher (*Haematopus bachmani*) breeding response to public use closures at Dungeness and Protection Island National Wildlife Refuges, Washington. Abstract of presentation given at Shorebird Science in the Western Hemisphere, 27 February-2 March 2006, Boulder, Colorado.

Savard, J.-P. L., D. Bordage, and A. Reed. 1998. Surf Scoter (*Melanitta perspicillata*). The Birds of North America 363:1-28.

Scheuhammer, A.M. 1987. The chronic toxicity of aluminum, cadmium, mercury and lead in birds: a review. Environmental Pollution 46:263-295.

Schick, C.T., L.A. Brennan, J.B. Buchanan, M.A. Finger, T.M. Johnson, and S.G. Herman. 1987. Organochlorine contamination in shorebirds from Washington State and the significance for their falcon predators. Environmental Monitoring and Assessment 9:115-131.

Spiegel, C.S., S.M. Haig, M.I. Goldstein, and B.A. Brown. 2006. Use of video cameras to document nest failure, nesting disturbance, and incubation behavior of Black Oystercatchers (*Haematopus bachmani*) in Alaska. Abstract of presentation given at Shorebird Science in the Western Hemisphere, 27 February-2 March 2006, Boulder, Colorado.

Sutherland, W.J. and J.D. Goss-Custard. 1991. Predicting the consequences of habitat loss on shorebird populations. Proceedings of the International Ornithological Congress 20:2199-2207.

Tenyo Maru Trustees. 1993. Tenyo Maru oil spill habitat impacts, resource injuries, damage claims and restoration summaries. Lacey, Washington.

Tessler, D.F., V.A. Gill, M.I. Goldstein, B. Guzzetti, R.B. Lanctot, J. Morse, S. Talbot, M. Tetreau, S. Haig, and C. Spiegel. 2006. An integrated regional ecological assessment of the Black Oystercatcher (*Haematopus bachmani*). Abstract of presentation given at Shorebird Science in the Western Hemisphere, 27 February-2 March 2006, Boulder, Colorado.

U.S. Department of Interior and U.S. Department of Commerce. 2002. 2001 national survey of fishing, hunting and wildlife-associated recreation. U.S. Government Printing Office, Washington, D.C.

Vermeer, K. 1981. Food and populations of Surf Scoters in British Columbia. Wildfowl 32:107-116.

Vermeer, K., K.H. Morgan, and G.E.J. Smith. 1992. Black Oystercatcher habitat selection, reproductive success, and their relationship with Glaucous-winged Gulls. Colonial Waterbirds 15:14-23.

Vermeer, K. and R. Verneer. 1975. Oil threat to birds on the Canadian west coast. Canadian Field-Naturalist 89:278-298.

Wahl, T.R., S.M. Speich, D.A. Manuwal, K.V. Hirsch, and C. Miller. 1981. Marine bird populations of the Strait of Juan de Fuca, Strait of Georgia and adjacent waters in 1978 and 1979. U.S. Environmental Protection Agency, DOC/EPA Interagency Energy/Environment R&D Progr. Rep. EPA/600/f-81/156.

Wahl, T.R., B. Tweit, and S.G. Mlodinow. 2005. Birds of Washington: status and distribution. Oregon State University Press, Corvallis, Oregon.

Warheit, K.I., D.R. Lindberg, and R.J. Boekelheide. 1984. Pinniped disturbance lowers reproductive success of Black Oystercatcher *Haematopus bachmani* (Aves). Marine Ecology Progress Series 17:101-104.

Warnock, N.D. and R.E. Gill. 1996. Dunlin (*Calidris alpina*). The Birds of North America 203:1-24.

Warnock, N.D., G.W. Page, and L.E. Stenzel. 1995. Nonmigratory movements of Dunlins on their California wintering grounds. Wilson Bulletin 107:131-139.

Washington Department of Fish and Wildlife and Washington Department of Community, Trade and Economic Development. 2004. Wildlife viewing activities in Washington a strategic plan. Report to the Washington State Legislature. Washington Department of Fish and Wildlife and Washington Department of Community, Trade and Economic Development, Olympia, Washington.

Wootten, T.J. 1995. Effects of birds on sea urchins and algae: a lower-intertidal trophic cascade. Ecoscience 2:321-328.

Ydenberg, R.C., R.W. Butler, D.B. Lank, B.D. Smith, and J. Ireland. 2004. Western Sandpipers have altered migration tactics as peregrine populations have recovered. Proceedings of the Royal Society of London (B) 271:1263-1269.

Appendix 1

Bird Species and Associated Habitats

Common and regularly occurring bird species associated with three general nearshore habitats in Puget Sound. Only the most prominent associations are shown, as some birds occasionally use other habitats. Most habitat associations are related to areas used during foraging or resting. Only four species in this table breed locally (on rocky shorelines or rocky bluffs). Significant predators (or, in some cases, scavengers) of some of these species include Bald Eagle (*Haliaeetus leucocephalus*), Peregrine Falcon (*Falco peregrinus*), Merlin (*Falco columbarius*) and Gyrfalcon (*Falco rusticolus*), the first three of which breed locally.

Common name	**Scientific name**	**Habitat associated with species occurrence**		
		Water	Tide flats	Rocky Shoreline
Snow Goose	*Chen caerulescens*		●	
Brant	*Branta bernicla*	●	●	
Gadwall	*Anas strepera*	●	●	
American Wigeon	*Anas americana*	●	●	
Mallard	*Anas platyrhynchos*	●	●	
Northern Pintail	*Anas acuta*	●	●	
Green-winged Teal	*Anas crecca*		●	
Canvasback	*Aythya valisineria*	●		
Greater Scaup	*Aythya marila*	●		
Lesser Scaup	*Aythya affinis*	●		
Harlequin Duck	*Histrionicus histrionicus*	●		
Surf Scoter	***Melanitta perspicillata***	●		
White-winged Scoter	*Melanitta fusca*	●		
Black Scoter	*Melanitta nigra*	●		
Long-tailed Duck	*Clangula hyemalis*	●		
Bufflehead	*Bucephala albeola*	●		
Common Goldeneye	*Bucephala clangula*	●		
Barrow's Goldeneye	*Bucephala islandica*	●		
Hooded Merganser	*Lophodytes cucullatus*	●		
Common Merganser	*Mergus merganser*	●		
Red-breasted Merganser	*Mergus serrator*	●		
Ruddy Duck	*Oxyura jamaicensis*	●		
Red-throated Loon	*Gavia stellata*	●		
Pacific Loon	*Gavia pacifica*	●		
Common Loon	*Gavia immer*	●		
Pied-billed Grebe	*Podilymbus podiceps*	●		
Horned Grebe	*Podiceps auritus*	●		
Red-necked Grebe	*Podiceps grisegena*	●		
Eared Grebe	*Podiceps nigricollis*	●		
Western Grebe	*Aechmophorus occidentalis*	●		
Brandt's Cormorant	*Phalacrocorax penicillatus*	●		
Double-crested Cormorant	*Phalacrocorax auritus*	●		
Pelagic Cormorant	*Phalocrocorax pelagicus*	●		

Common name	Scientific name	Habitat associated with species occurrence		
		Water	Tide flats	Rocky Shoreline
Great Blue Heron	*Ardea herodias*		●	
Green Heron	*Butorides virescens*		●	
Osprey	*Pandion haliaetus*	●		
Bald Eagle	*Haliaeetus leucocephalus*	●	●	
American Coot	*Fulica americana*	●		
Black-bellied Plover	*Pluvialis squatarola*		●	
Semipalmated Plover	*Charadrius semipalmatus*		●	
Black Oystercatcher	***Haematopus bachmani***			●
Greater Yellowlegs	*Tringa melanoleuca*		●	
Spotted Sandpiper	*Actitis macularius*		●	
Ruddy Turnstone	*Arenaria interpres*			●
Black Turnstone	*Arenaria melanocephala*			●
Surfbird	*Aphriza virgata*			●
Sanderling	*Calidris alba*		●	
Western Sandpiper	*Calidris mauri*		●	
Least Sandpiper	*Calidris minutilla*		●	
Pectoral Sandpiper	*Calidris melanotos*		●	
Dunlin	***Calidris alpina***		●	
Short-billed Dowitcher	*Limnodromus griseus*		●	
Long-billed Dowitcher	*Limnodromus scolopaceus*		●	
Red-necked Phalarope	*Phalaropus lobatus*	●		
Parasitic Jaeger	*Stercorarius parasiticus*	●		
Bonaparte's Gull	*Larus philadelphia*	●		
Mew Gull	*Larus canus*	●		
Ring-billed Gull	*Larus delawarensis*	●		
California Gull	*Larus californicus*	●		
Herring Gull	*Larus argentatus*	●		
Thayer's Gull	*Larus thayeri*	●		
Western Gull	*Larus occidentalis*	●		
Glaucous-winged Gull	*Larus glaucescens*	●		
Caspian Tern	*Hydroprogne caspia*	●		
Common Tern	*Sterna hirundo*	●		
Common Murre	*Uria aalge*	●		
Pigeon Guillemot	*Cepphus columba*	●		●
Marbled Murrelet	*Brachyramphus marmoratus*	●		
Ancient Murrelet	*Synthliboramphus antiquus*	●		
Rhinoceros Auklet	*Cerorhinca monocerata*	●		
Belted Kingfisher	*Ceryle alcyon*	●		●

PSNERP and the Nearshore Partnership

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) was formally initiated as a General Investigation (GI) Feasibility Study in September 2001 through a cost-share agreement between the U.S. Army Corps of Engineers and the State of Washington, represented by the Washington Department of Fish and Wildlife. This agreement describes our joint interests and responsibilities to complete a feasibility study to

"…*evaluate significant ecosystem degradation in the Puget Sound Basin; to formulate, evaluate, and screen potential solutions to these problems; and to recommend a series of actions and projects that have a federal interest and are supported by a local entity willing to provide the necessary items of local cooperation.*"

The current Work Plan describing our approach to completing this study can be found at:

http://pugetsoundnearshore.org/documents/StrategicWorkPlanfinal.pdf

Since that time, PSNERP has attracted considerable attention and support from a diverse group of individuals and organizations interested and involved in improving the health of Puget Sound nearshore ecosystems and the biological, cultural, and economic resources they support. The **Puget Sound Nearshore Partnership** is the name we have chosen to describe this growing and diverse group, and the work we will collectively undertake that ultimately supports the goals of PSNERP, but is beyond the scope of the GI Study. Collaborating with the Puget Sound Action Team, the Nearshore Partnership seeks to implement portions of their Work Plan pertaining to nearshore habitat restoration issues. We understand that the mission of PSNERP remains at the core of our partnership. However, restoration projects, information transfer, scientific studies, and other activities can and should occur to advance our understanding and, ultimately, the health of the Puget Sound nearshore beyond the original focus and scope of the ongoing GI Study.

As of the date of publication for this Technical Report, our partnership includes participation by the following entities:

- King Conservation District
- King County
- National Wildlife Federation
- NOAA Fisheries
- NOAA Restoration Center
- Northwest Indian Fisheries Commission
- Northwest Straits Commission
- People for Puget Sound
- Pierce County
- Puget Sound Partnership
- Recreation and Conservation Office
- Salmon Recovery Funding Board
- Taylor Shellfish Company
- The Nature Conservancy
- U.S. Army Corps of Engineers
- U.S. Department of Energy
- U.S. Environmental Protection Agency
- U.S. Geological Survey
- U.S. Fish and Wildlife Service
- U.S. Navy
- University of Washington
- Washington Department of Ecology
- Washington Department of Fish and Wildlife
- Washington Department of Natural Resources
- Washington Public Ports Association
- Washington Sea Grant
- WRIA 9

Document produced by Washington Sea Grant

Puget Sound
Nearshore
Partnership

RESTORING OUR
ECOSYSTEM HEALTH

Puget Sound Nearshore Partnership/
Puget Sound Nearshore Ecosystem Restoration Project

c/o Washington Department of Fish and Wildlife

Mailing Address: 600 Capitol Way North,
Olympia, Washington 98501-1091

Contact: *pugetsoundnearshore@dfw.wa.gov*
or vist our website at: *www.pugetsoundnearshore.org*